Claims

1. A method for milling spiral bevel gears and hypoid gears using profile-sharpened or profile-sharpened and additionally form-ground bar cutting blades each having a shank and at one end of the shank a cutting edge profile which enables a first tooth flank, at least a portion of the bottom of the tooth slot, and least a portion of a second tooth flank lying opposite said first tooth flank to be cut in a tooth slot,

characterized by the step of using for the milling of a bevel gear at least one bar cutting blade with which each tooth slot is generated to a complete final geometry in one complete milling pass.

2. The method as claimed in claim 1, characterized by the step of generating the final geometry by the hobbing method.

3. The method as claimed in claim 1, characterized by the step of generating the final geometry by the plunge milling method.

4. The method as claimed in any one of the preceding claims, characterized by being carried out as a rough milling process and/or a finish milling process.

5. A profile-sharpened or profile-sharpened and additionally form-ground bar cutting blade for milling spiral bevel gears and hypoid gears, with a shank and with a cutting edge profile formed at one end of the shank by the intersection of at least one rake surface, at least two clearance surfaces and at least one top surface, said cutting edge profile including, for producing a tooth slot, a first cutting edge for a first tooth flank, a second cutting edge for at least a portion of the second tooth flank opposite said first tooth flank, and a top cutting edge for at least a portion of the bottom of the tooth slot,

characterized in that the first and second cutting edges (16, 18) are designed as cutting edges for completely cutting the first and second tooth flanks (53, 54), respectively, and that the top cutting edge (20) is designed for completely cutting the bottom (52) of the tooth slot, thus enabling the tooth slot (51) to be generated to its complete final geometry using one and the same bar cutting blade (10, 11, 11') in one milling pass.

6. The bar cutting blade as claimed in claim 5, characterized in that the cutting edge profile is formed by the intersection of one and the same rake surface (22, 24, 26) with at least the two clearance surfaces (17, 19) and the top surface (21).

7. The bar cutting blade as claimed in claim 5, characterized in that the cutting edge profile is formed by the intersection of two relatively angled rake surfaces (24v, 24x) with at least the two clearance surfaces (17, 19) and the top surface (21).

8. The bar cutting blade as claimed in claim 5 or 6, characterized in that the first and second cutting edges (16, 18) have rake angles (Y_{SX}, Y_{SV}) equaling zero degrees in either case.

9. The bar cutting blade as claimed in claim 5 or 6, characterized in that the first and second cutting edges (16, 18) have rake angles (Y_{SX}, Y_{SV}) greater than zero degrees in either case.

10. The bar cutting blade as claimed in claim 5 or 6, characterized in that the first and second cutting edges (16, 18) have rake angles (Y_{SX}, Y_{SV}) smaller than zero degrees in either case.

11. The bar cutting blade as claimed in any one of claims 5 to 7, characterized in that the first and second cutting edges (16, 18) have rake angles (Y_{SX}, Y_{SV}) one of which is greater than zero degrees and the other of which is smaller than zero degrees.

12. The bar cutting blade as claimed in any one of the preceding claims, characterized in that the rake surface (22) is worked into the shank (12) unalterably.

13. The bar cutting blade as claimed in claim 9, characterized in that the rake surface (26) between the first and second cutting edges (16, 18) is curved in a concave configuration.

14. The bar cutting blade as claimed in any one of claims 5 to 11 or 13, characterized in that for form-grinding the bar cutting blade (10) the rake surface or each rake surface (24, 26; 24v, 24x) is a rake surface to be reground.

15. A use of at least one profile-sharpened or profile-sharpened and additionally form-ground bar cutting blade (10, 11, 11') as claimed in any one of claims 5 to 14 with a method for milling spiral bevel gears and hypoid gears with a cutter head (40) wherein the or each bar cutting blade (10, 11, 11') is arranged in an end face (42) of the cutter head (40) on a circle and in use has the cutting end of the shank (12) protrude from the end face (42) of the cutter head (40).

REVISED CLAIMS

[Received with the International Bureau on October 25, 2004 (10/25/04), claims 1 to 15 as originally filed replaced by claims 1 - 15 as amended]

+ DECLARATION

[Amended Claims under Art. 19(1) PCT: Claim 1 is substituted for claim 1 as originally filed; claims 2 - 15 correspond to claims 2 - 15 as originally filed]

1. A method for milling spiral bevel gears and hypoid gears using profile-sharpened or profile-sharpened and additionally form-ground bar cutting blades each having a shank and at one end of the shank a cutting edge profile which enables a first tooth flank, at least a portion of the bottom of the tooth slot, and least a portion of a second tooth flank lying opposite said first tooth flank to be cut in a tooth slot,

characterized by the step of cutting completely, that is, not only in sections, in a single milling pass using the cutting edge profile of a bar cutting blade: the first tooth flank, the bottom of the tooth slot, and the second tooth flank opposite the first tooth flank of each tooth slot of a bevel gear to be milled.

2. The method as claimed in claim 1, characterized by the step of generating the final geometry by the hobbing method.

3. The method as claimed in claim 1, characterized by the step of generating the final geometry by the plunge milling method.

4. The method as claimed in any one of the preceding claims, characterized by being carried out as a rough milling process and/or a finish milling process.

5. A profile-sharpened or profile-sharpened and additionally form-ground bar cutting blade for milling spiral bevel gears and hypoid gears, with a shank and with a cutting edge profile formed at one end of the shank by the intersection of at least one rake surface, at least two clearance surfaces and at least one top surface, said cutting edge profile including, for producing a tooth slot, a first cutting edge for a first tooth flank, a second cutting edge for at least a portion of the second tooth flank opposite

said first tooth flank, and a top cutting edge for at least a portion of the bottom of the tooth slot,

characterized in that the first and second cutting edges (16, 18) are designed as cutting edges for completely cutting the first and second tooth flanks (53, 54), respectively, and that the top cutting edge (20) is designed for completely cutting the bottom (52) of the tooth slot, thus enabling the tooth slot (51) to be generated to its complete final geometry using one and the same bar cutting blade (10, 11, 11') in one milling pass.

6. The bar cutting blade as claimed in claim 5, characterized in that the cutting edge profile is formed by the intersection of one and the same rake surface (22, 24, 26) with at least the two clearance surfaces (17, 19) and the top surface (21).

7. The bar cutting blade as claimed in claim 5, characterized in that the cutting edge profile is formed by the intersection of two relatively angled rake surfaces (24v, 24x) with at least the two clearance surfaces (17, 19) and the top surface (21).

8. The bar cutting blade as claimed in claim 5 or 6, characterized in that the first and second cutting edges (16, 18) have rake angles (Y_{SX}, Y_{SV}) equaling zero degrees in either case.

9. The bar cutting blade as claimed in claim 5 or 6, characterized in that the first and second cutting edges (16, 18) have rake angles (Y_{SX}, Y_{SV}) greater than zero degrees in either case.

10. The bar cutting blade as claimed in claim 5 or 6, characterized in that the first and second cutting edges (16, 18) have rake angles (Y_{SX}, Y_{SV}) smaller than zero degrees in either case.

11. The bar cutting blade as claimed in any one of claims 5 to 7, characterized in that the first and second cutting edges (16, 18) have rake angles (Y_{SX}, Y_{SV}) one of which is greater than zero degrees and the other of which is smaller than zero degrees.

12. The bar cutting blade as claimed in any one of the preceding claims, characterized in that the rake surface (22) is worked into the shank (12) unalterably.

13. The bar cutting blade as claimed in claim 9, characterized in that the rake surface (26) between the first and second cutting edges (16, 18) is curved in a concave configuration.

14. The bar cutting blade as claimed in any one of claims 5 to 11 or 13, characterized in that for form-grinding the bar cutting blade (10) the rake surface or each rake surface (24, 26; 24v, 24x) is a rake surface to be reground.

15. A use of at least one profile-sharpened or profile-sharpened and additionally form-ground bar cutting blade (10, 11, 11') as claimed in any one of claims 5 to 14 with a method for milling spiral bevel gears and hypoid gears with a cutter head (40) wherein the or each bar cutting blade (10, 11, 11') is arranged in an end face (42) of the cutter head (40) on a circle and in use has the cutting end of the shank (12) protrude from the end face (42) of the cutter head (40).

Declaration under Art. 19(1) PCT

U.S. Pat. No. 4,575,285 A describes, similar to document EP 0 203 085 B1 previously considered in the description part of the application, a method of milling spiral bevel gears and hypoid gears with profile-sharpened or profile-sharpened and additionally form-ground bar cutting blades each of which has a base portion or shank and at one end of the shank a cutting edge profile enabling at least a first flank to be cut in a tooth slot. The prior art on which the method described in U.S. Pat. No. 4,575,285 is based employs groups of cutting tools or cutting blades for this task, whereof each cutting blade group includes an outside cutting blade to remove stock from the outside or concave flank of a tooth slot, an inside cutting blade to remove stock from the inside or convex flank of a tooth slot, and a rough cutting tool to remove stock from the bottom of the tooth slot. In the bar cutting blade of U.S. Pat. No. 4,575,285 A, the cutting edge profile is designed so that the rough cutting tool may be eliminated. Therefore, a group of bar cutting blades comprises only two bar cutting blades, which is the reason why more groups of bar cutting blades can be accommodated on a cutter head. The second cutting edge provided on an outside or inside cutting blade of each cutting blade group performs an additional cutting function by cutting also a portion of the opposite second tooth flank and a portion of the bottom of the tooth slot. In this arrangement the second cutting edges are conventionally designed as rough cutting edges (column 1, lines 45-53). Thus, in the embodiment of FIG. 6 of U.S. Pat. No. 4,575,285 A, in the use of a group of bar cutting blades comprised of an inside cutting tool 48 and an outside cutting tool 50, the surface of a tooth slot can be rough cut first by the rough cutting edge or second cutting edge 64 of the inside cutting tool 48 and then finish cut by the first cutting edge 62 of the outside cutting tool. Conversely, other tooth slot surfaces which are rough cut by the second cutting edge 66 of the outside cutting tool 50 can be finish cut by the first cutting edge 60 of the inside cutting tool 48, but it is also contemplated that in a single tool both cutting edges are designed such that all the surfaces of the tooth slot being formed in a workpiece are finish cut (column 4, lines 12-19). Regardless of whether a bar cutting blade uses its first side for performing a finishing cut and its second side to perform a roughing cut, or whether both sides of each bar cutting blade perform a finishing cut, the known method necessitates groups of cutting blades that are comprised of two

cutting blades in each case, because the second cutting edge of each cutting blade can only cut one portion of its assigned tooth flank at a time. The reason for this lies in the special design of the cutting tool of U.S. Pat. No. 4,575,285 A, in which the second cutting edge is obtained by producing in the cutting face a slot that forms the second cutting edge which, accordingly, is shorter than the first flank and only able to cut a portion of the bottom of the tooth slot as well as a portion of its assigned flank (column 2, lines 44-48 and column 3, lines 26-28). As delimitation relative to this prior art and for closer definition, it has been made clear in claim 1 that with the cutting edge profile of a bar cutting blade the first tooth flank, the bottom of the tooth slot, and the second tooth flank opposite the first tooth flank of each tooth slot of a bevel gear to be milled can be cut completely, that is, not only in sections, in a single milling pass, so that the tooth slot can be produced to its complete final geometry using one and the same bar cutting blade in one milling pass. The cutting blade groups required according to U.S. Pat. No. 4,575,285, which are each comprised of two bar cutting blades, can thus be replaced by one cutting blade in each case, resulting in the possibility of doubling the number of bar cutting blades insertable in a cutter head.